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TITLE: # High Fidelity Urban Scale Modeling

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Chem-bio releases in the atmosphere induce impacts over several spatial scales, both in the near field (close to the source) and out to the far field, potentially many kilometers downwind. While the most severe effects from typical chemical releases are confined to areas relatively close to the source, biological releases at small or moderate amounts can be lethal at much farther distances downstream and over a significantly larger area. For plumes originating in urban areas, the larger-scale transport may depend on the near-source dispersal patterns within the city. In addition, the near-source dispersal behavior within the urban canopy may depend on the larger-scale flow features.

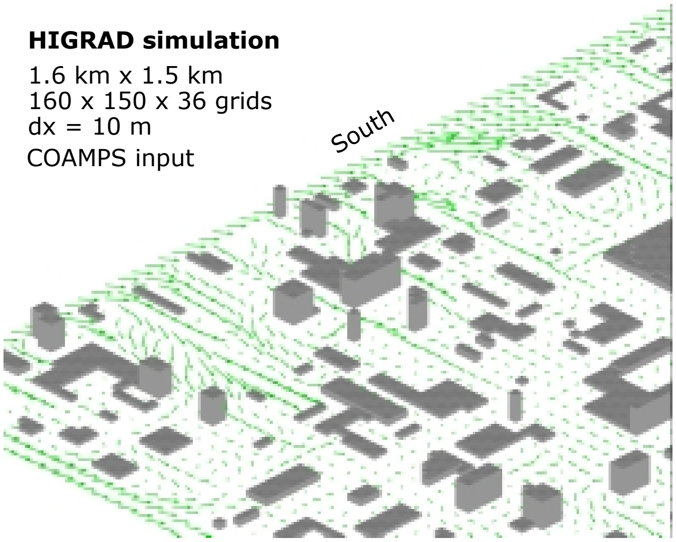

Figure 1. HIGRAD simulation of wind flow in the southeast corner of downtown Salt Lake City.

Investigators at Los Alamos National Laboratory have developed a hybrid engineering and meterological computational fluid dynamics model called HIGRAD that can simulate the transport and fate of chem-bio agents from the building to regional scales (Reisner et al., 1998). The "High Gradient" model solves the 3-d Navier-Stokes equations in a terrain-following coordinate system. The model is second-order accurate and uses a non-oscillatory forward-in-time advection scheme that can accurately model regions of strong shear. The model can be run in an anelastic mode using an efficient conjugate residual pressure solver or in a compressible mode using the method of averages. Turbulence closure is accomplished using a Smagorinsky-type or a TKE-based large eddy simulation (LES) scheme. The code solves a full surface energy budget equation and includes shading effects. The code combines both the important larger scale meteorological processes and those

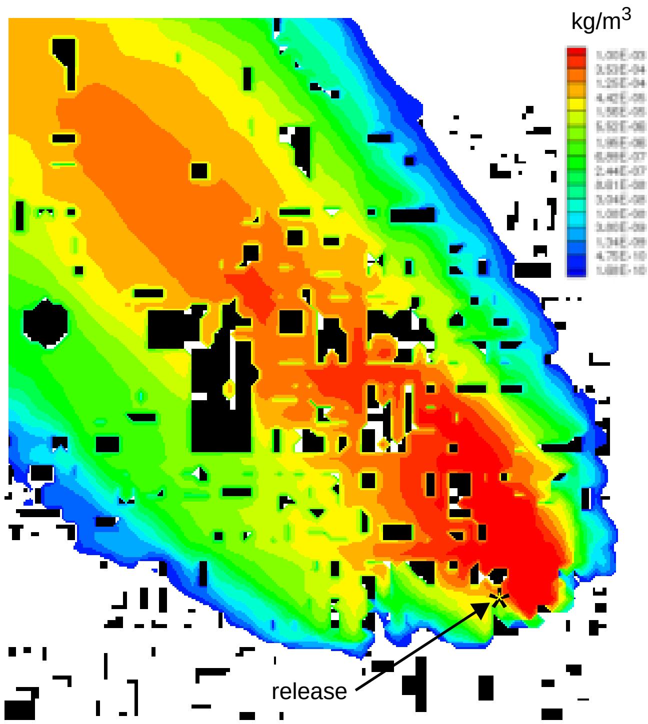

Figure 2. HIGRAD simulation of ground-level concentrations of a release in the southeast corner of downtown Salt Lake City. The prevailing upper-level wind is out of the southeast.

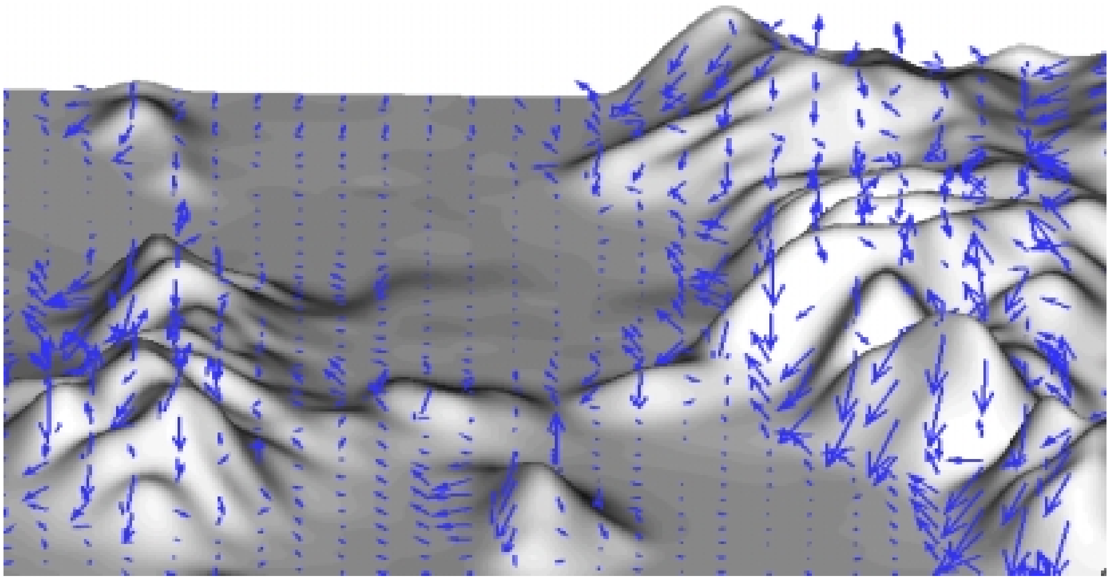

Figure 3. HIGRAD simulation of early morning drainage winds in the Salt Lake City basin. The numerical mesh contained 176X276X51 grids with a constant 500 m horizontal resolution and a vertical resolution ranging from 20 m at the surface to 200 m at 10 km.

found on the smaller engineering scales making it adept for the neighborhood urban scale out to the complex terrain mesoscale.

Figure 1 shows the complex wind fields that develop in and around a building array. The plume dispersal of a ground-level release in a parking lot in the southwest corner of downtown Salt Lake City is modeled in Figure 2. Notice the “fingers” of agent that travel up side streets. Three dimensional visualization shows that the buildings act to loft a significant fraction of the plume into the air. Figure 3 reveals the complex wind fields that develop due to cold air drainage from the mountains and canyons surrounding Salt Lake City.

As part of the DOE’s CBNP program, the Los Alamos and Lawrence Livermore National Laboratories are working together on a multi-scale modeling system (e.g., Brown et al., 2000). Flow and dispersion predictions are performed within "nested" domains with increasing spatial resolution from regional to intermediate/ urban to building scales. Here, the LLNL version of the NRL COAMPS model is used to perform regional scale meteorological simulations, the HIGRAD model performs the basin scale to neighborhood urban scale simulations, and the LLNL FEM3MP model is used to resolve building scale features at high resolution. The results from these models can be used for emergency planning of special events, vulnerability analyses, and the development of mitigation strategies. A longer term deliverable is to integrate this capability into the NARAC chem-bio emergency response system.

Brown, M., M. Leach, J. Reisner, D. Stevens, S. Smith, H.-N. Chin, S. Chan, and B. Lee (2000) Numerical modeling from mesoscale to urban scale to building scale, AMS 3rd Urb. Env. Symp., Davis, CA.

Reisner, J., W. Smith, J. Bossert, & J. Winterkamp (1998) Tracer modeling in an urban environment, 2nd AMS Urb. Env. Symp., Albuquerque, NM.

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